You have already seen how exceedingly important it was to use a slit instead of a round hole in these experiments. It was the verdict of Wollaston, and it was the verdict of Becquerel and Draper, as I have shown you to-night with regard to photography. You have also seen that we can use the circular corona as a slit equally well.

Now if we take a long slit and divide it into as many portions as we choose, we see at once the improvement that we introduce into spectroscopic photography. All we have to do is to divide that slit into portions, as it were, by letting a window run down the slit, and when the window has arrived at the second part of the slit, let in light from a new source. This principle has been carried out practically in the following manner :—A rectangular brass plate 71 mm. long, and 35 mm. broad, slides in grooves in front of the slit of the spectroscope, and a window 4 mm. high, cut out of this plate, leaves a portion of the slit of this length exposed. A small pin presses firmly against the face of one of the sliding plates, and a row of small shallow holes or notches is drilled in the plate so as to intercept it in its upward or downward movement at those points where the pin falls into a notch. The distance between the notches is precisely the same as the height of the opening cut in the sliding plate, so that the movement of this plate from one notch to another corresponds to a distance equal to the height of the exposed part of the slit, and the spectra compared are confronted, so to speak, absolutely ; the upper edge of one spectrum abuts against the lower edge of the other, and the coincidence, or want of coincidence, between lines in the two spectra can thus be determined with the greatest precision. The spectroscope employed contains three prisms of 45° and one of 60° ; its observing telescope is replaced by a camera with a 3-in. lens by Dallmeyer of about 23 in. focal length for the use of which I am indebted to Lord Lindsay. With this arrangement—the spectrum being received upon a sensitised $\frac{1}{4}$ plate—the portion between the wave-lengths, 3,900 and 4,500, can be obtained at once in good focus. A ray of sunlight, reflected from a heliostat mirror so as to fall upon the slit-plate, is brought to a focus by means of a double convex lens just between the carbon poles of an electric lamp, while a second convex lens placed between the lamp and the collimator tube, serves to cast an image of the sun or of the electric arc upon the slit-plate. Supposing, now, we wished to compare the iron spectrum with that of the sun : the sun's image in sharp focus on the slit-plate is first allowed to imprint its spectrum on the prepared plate. The ray of sunlight is then cut off, the sliding plate moved up or down till the pin catches in the next notch, and the image of the arc, passing between an upper pole of carbon and a lower pole consisting of a carbon crucible containing a fragment of iron, is allowed to fall on the portion of the slit thus exposed.

Let me show you some photographs illustrating this description. Here is a single photographic plate on which the new method has enabled us to register no less than four different spectra ; those of you who are familiar with photographic processes will immediately see how it is that the number is not forty instead of four. Having a slit of a certain length, if I open all the length of that slit at once I should get a spectrum the breadth of which would depend upon the length of the slit ; but if I commence operations by allowing the light first to come through one small portion of the slit, then we shall get the light from the particular metal which I employ in the electric arc falling on one part of the plate, and registering itself on the photographic plate. Then, if I close up that part of the slit, and open another one, I shall be able, through that newly opened part of the slit, all the rest being closed, to photograph on the plate the spectrum of another substance, say iron. Then, having used up that part of the plate, I can close that portion of the slit, I can bring my window lower down, and there we have the spectrum of cobalt. The window has been brought farther down, and there we have the spectrum of nickel, so that we have, as the work of some eight or nine minutes at the outside, a photograph—not a perfect one in this case, but this was the first one taken on this method—which will register with the most absolute and complete accuracy and certainty not less than 1,000 lines. Now a careful student of those lines, working as hard as he can, thinks himself very fortunate if he can lay down ten an hour. Therefore, as ten an hour are to 1,000 in seven minutes, so is the eye to photography in these matters.

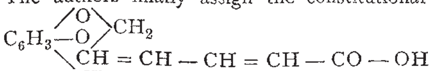
I have a photograph of a somewhat similar nature, which I am anxious to place before you. We have here an absolute comparison rendered possible, by means of photography, between the lines of the spectrum of iron and the lines of the spectrum of the sun. You see that in the case of most of the thick lines, you get a thick line in the solar spectrum corresponding with the lines of the iron. And, more than this, you see, I hope, all of you, that these lines of iron are of different lengths. The reason of that is that I have been careful to photograph on the plate the lines due to the various strata of iron vapour, from the rarest vapour, which is obtained at the outside of the electric arc, to the densest, which occupies the centre of the core, and you will see the most beautiful gradation as we pass from the outside part of the spectrum to the inside. This inside part represents the complete spectrum of the core, and the outside the incomplete and almost mono-chromatic spectrum of the vapour which surrounds the denser core in the middle of the spark ; thus we have practically reduced the spectrum of iron to one line, instead of 460. That is the first photograph of the kind which has been taken ; I say that, not because I am proud of it, but because you all know how enormously photographic processes are likely to be developed the moment, not one individual, but a great many, try their hands upon them, so that an enormous improvement upon what you now see may be anticipated. Not only have we developed, in the application of photography to spectroscopy, a valuable ally to Science, as we have in the application of photography to astronomy—and you know what that has done, and what it is going to do—but we have, I believe, what we may almost call a new chemistry, some day to be revealed to us by means of photographic records of the behaviour of molecules. Recollect that the difference between the iron spectrum of one line and the iron spectrum of between 400 and 500 lines is simply due to the difference in the arrangements of the molecules or atoms of iron in the centre of the electric arc and its exterior. There is one question which all lovers of the spectroscope may ask of photographers, and that is this, why should we any longer be confined, in registering spectra, to the more refrangible end of the spectrum, when one of the very first spectra of the sun that was ever taken was a complete photograph of the spectrum, including not only the blue, the green, and the yellow, but the red, and the extreme red? I think that if photographers will study the action of light on molecules, and read that extraordinary paper of Becquerel's, and will give those who are familiar with the spectroscope, and those who are anxious to promote the progress of spectroscopic research, a means of extending photographic registration, not only into the green part of the spectrum, which they do already with difficulty, but to the extreme red, then the use of the eye will almost entirely be abolished in these inquiries. And although no one has a higher estimate than myself of the extreme importance of the eye, I think that the more it is replaced by permanent natural records in these inquiries, the better it will be for the progress of Science.

J. NORMAN LOCKYER

SCIENTIFIC SERIALS

THE current number of the *Quarterly Journal of Microscopic Science* contains several papers of interest. Dr. Michael Foster commences with an article On the term Endothelium, in which he proves that the word is etymologically pure nonsense, Ruysch's word epithelium signifying that it covers papillæ. His endothelium must be understood to mean *that it is inside a papilla.* It is also valueless for other reasons : for if it is defined as that epithelium developed from the germinal mesoblast, the epithelium of the Wolffian ducts, of the ureters, and of Muller's ducts would have to be included. Therefore the term is insignificant and must be abolished. *Monoderic* and *polyderic* are proposed as terms to indicate that the cells form one or several layers.—The second part of Prof. Haeckel's interesting Gastræa theory follows, in English. In it the systematic and the phylogenetic signification of the Gastræa theory and the ontogenetic succession of the system of organs are discussed, as well as the bearing of the whole on the theory of types. The author is so prolific in his introduction of new words, the definitions of many of which are to be found in other publications, that a Haeckel Glossary in the next number of the *Journal* would not be out of place, to assist readers in the full appreciation of that illustrious biologist's very suggestive theory.—Mr. J. W. Groves explains his method of arranging and cataloguing microscopic specimens.—A paper follows by Mr. E. C. Baber On picro-carminate of ammonia as a microscopic staining fluid, in which he explains M. Ranvier's method. The great advantage of this reagent is shown to consist in its staining tissues in a series of colours varying from red to yellow; it also acts rapidly and can be kept in a dry form.—The Rev. E. O'Meara describes a collection of Diatomaceæ from Spitzbergen, including many species not enumerated by Cleve's Diatoms of the Arctic Sea.—Mr. Buck describes and figures a new Polyzoon belonging to the family *Halcyonelleæ*, named by him *Clavopora hystricis*, from a single specimen obtained in the expedition of the *Porcupine* in the Mediterranean.—An article from the *Indian Medical Gazette*, On the etiology of Madura foot, is discussed, the vegetable origin of that disease being severely handled. A note by the Rev. M. J. Berkeley is appended, strongly supporting Dr. V. Carter's original observations.—Dr. W. G. Farlow, of Harvard University, writes On a sexual growth from the prothallus of *Pteris cretica*, in which he shows that whilst in some of the prothalli archegorina and antheridia were developed, others gave rise to young fern-plantlets by a direct budding of the cells, without any sexual intervention. The paper is illustrated with two plates.—Mr. E. R. Lankester has two papers, one on *Torquatella typica*, a new type of Infusoria, allied to the Ciliata, from Naples; peculiar in not possessing cilia, not even round the oral region and capitular prominence, but in their place a bell-like prolongation of the body-wall like a ring of united cilia. The second paper is on the heart of *Appendicularia furcata*, in which that organ is shown to consist of two nucleated cells connected by fourteen or so slender vibratile fibrillæ, whose mutual connection by a membrane is uncertain. This organ is thus nothing more than a "most vigorous churn, beating and stirring up the fluid in the great perivisceral hæmolymph space without propelling it in any particular direction." The paper ends with some suggestive remarks on the reduction of the structure of organs in diminutive elaborate types generally.

Justus Liebig's Annalen der Chemie und Pharmacie.—Band 172, Heft 2.—The following papers are published in this part:—On the salts of parabanic acid, by N. Menshutkin. The formula of the ammonium salt is $C_3H_2N_2O_3.NH_3$; by the action of water on the salt the ammonium salt of oxaluric acid is produced, and by the action of heat alone oxaluramide. The potassium and sodium salts have likewise been examined and two silver salts obtained, of which the formulæ are $C_3HAgN_2O_3.H_2O$ and $C_3Ag_2N_2O_3.H_2O$.—The same author contributes a paper entitled, "Notice on potassium oxalurate and the determination of the alkaline metals in the salts of the acids belonging to the uric acid group."—On the oxidation products of colophony and oil of turpentine, by Dr. Josef Schreder. By digesting colophony with dilute sulphuric acid, isophthalic acid ($C_8H_6O_4$) and trimellithic acid ($C_9H_6O_6$) are obtained. Turpentine oil oxidised by dilute nitric acid, gives terebinic and terephthalic acids.—On the conversion of cinchonidine into an oxy-base, by Dr. J. Skalivert. Cinchonidine is mixed with carbon disulphide and bromine dropped into the mixture. A brominated compound of the formula $C_{20}H_{22}Br_2N_2O$ is thus obtained, which on treatment with potassium hydrate yields the new oxy-base $C_{20}H_{24}N_2O_3$. Analyses of the sulphate and of the double Pt salt are given.—On ferrous anhydrosulphate, by T. Bolas, already noticed in the Journal of the Chemical Society.—The following are communications from the Tübingen laboratory:—(1) On the cyan- and carboxyl derivatives of diphenyl, by Oscar Doebner.—(2) On normal phenyl propyl alcohol and allylbenzene, by Leopold Rügheimer.—(3) Researches on the synthesis of allylbenzene, by Rudolf Fittig.—(4) Researches on the constitution of piperine and its decomposition products piperic acid and piperidine, by R. Fittig and W. H. Mielck. This is the fourth notice on the subject, and the authors now touch upon the constitution of piperic acid. By the action of bromine a tetra-brominated acid $C_{12}H_{10}Br_4O_4$ is obtained which by the action of sodium carbonate is converted into the dibrominated compound $C_{12}H_8Br_2O_4$. This last substance boiled with soda solution and precipitated by an acid yields a monobrominated body of the formula $C_{12}H_8BrO_5$. The authors next proceed to the consideration of a new acid which they have obtained by acting upon monobrompiperonal with bases, and then decomposing the salt produced by means of hydrochloric acid. The new acid has the formula $C_{12}H_{10}Br_4O_5$, and must be regarded as the substitution product of the acid $C_{12}H_{14}O_5$. By the action of soda on the sodium salt of the new acid an intermediate compound having the formula $C_{12}H_8Br_2O_5$ has been produced. Bromine dropped into a solution of hydropiperic acid in carbon disulphide, gives rise to the formation of the compound $C_{12}H_{12}Br_2O_4$. In the concluding section the decomposition of hydropiperic acid by means of fused potassium hydrate is treated of. The chief product of the reaction is protocatechuic acid, $C_7H_6O_4, H_2O$. The authors finally assign the constitutional formula



$$C_6H_3\begin{cases}-O\\-O\end{cases}\!\!\!>CH_2 \qquad C_6H_3-CH=CH-CH=CH-CO-OH$$

to piperic acid.—The part concludes with papers by Peter Greiss On the sulphurisation of sulphurobenzoic acid or dicarboxylsulphocarbanilide, and by M. G. Gustavson On tetra-iodide of carbon. This substance has been obtained by the action of aluminic iodide on CCl_4 according to the equation—

$$3CCl_4 + 2Al_2I_6 = 2Al_2Cl_6 + 3CI_4.$$

The substances are made to react in carbon disulphide solutions.

Gazzetta Chimica Italiana, Fascicolo V., 1874. This part contains the following papers:—On the extraction of sulphur, by F. Sestini.—On the action of sulphur on earthy carbonates, particularly on neutral calcium carbonate, with regard to geology and agriculture, by Prof. Egidio Pollacci. This paper was communicated in April to the Reale Istituto Lombardo di Scienze e Lettere. The author's principal object is to prove that a mixture of sulphur and calcium carbonate acted upon by water with free access of air gives rise to the formation of calcium sulphate. The chemical changes are thus expressed—

$$2S + 3O_2 + 2H_2O = 2H_2SO_4$$
$$2H_2SO_4 + 2CaCO_3 = 2CaSO_4 + 2CO_2 + 2H_2O.$$

The author is of opinion that the oxidation of the sulphur is effected *directly* by atmospheric oxygen in presence of $CaCO_3$ and water.—The concluding paper is entitled Chemical Research on Turkey Red, by Prof. Abelardo Romegialli. The remainder of the part is devoted to abstracts from foreign periodicals.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, July 1.—This number contains an article by Dr. J. Hann On the diminution of atmospheric vapour with increase of elevation. Experiment and mathematical theory both deny the existence of an independent vapour atmosphere, which according to Dalton's law would decrease much less rapidly with elevation than atmospheric vapour really does. Hence Mr. Strachey (Proceedings of the Royal Society, March 1861) would not deduct the vapour pressure from the height of the barometer to obtain the pressure of dry air. From a table showing the actual decrease of vapour tension with increase of height, observed in various ascents of mountains and in balloons, is derived a formula to express this decrease. Thus where p and p_0 stand for the pressures at the height h and at the surface of the earth, h being measured in units of 1,000 English feet,

$$(1)\ p = p_0\,(1 - 0{\cdot}075\,h + 0{\cdot}00146h^2)$$

and where e is the bases of natural logarithms, and h in units of 1,000 metres,

$$(2)\ p = p_0\,10 - \frac{h}{6517} = p_0 e - \frac{h}{2830}$$

If atmospheric vapour obeyed the law of Dalton, its weight over any place would be four and a half times greater than the real weight. Dr. Hann calculates the weight of vapour at 1,962 metres to be only half, at 6,500 metres one-tenth, of the weight at the surface of the earth. With respect to this rapid decrease of moisture, Strachey remarked that mountain chains, even of moderate altitude, must have great influence upon the hygrometric state of the atmosphere. The above formula can only be used safely for calculating the *mean* pressure of vapour at a given height. It may be useful for barometric measurements of altitudes, since it frequently happens that the vapour pressure of only one of two stations, of which the difference in height is required, is known. Observed values, up to 1,884 metres, have been actually found to agree well with those calculated by the formula. This formula may be only another expression for the opinion of Strachey, that the mean degree of saturation at different heights remains nearly uniform, and therefore the vapour tension depends merely on decrease of temperature. But the calculation of the mean vapour pressure of one level from that of another level with so great accuracy appears not to have been hitherto accomplished.

Annali di Chimica applicata alla Medicina, t. lviii., No. 5.—In dietetics there is a paper by Dr. F. Turbacco On cheese and its alimentary use.—Beaumertz furnishes a contribution on farinaceous substances as food for children.—In pathology there is a paper by Dr. L. Ledeganck (translated from *La Presse Médicale Belge*) On the action of parasitic organisms in the production of necrosis.—In therapeutics we have the following papers:—On the anæsthesia produced in man by the injection of chloral into the veins, by Oré.—Under the heading "Varieties" there is a paper by Prof. Fausto Sestini On the chemical composition of mulberry leaves; one On a new method of extracting logwood for vines and inks, from the agricultural chemical laboratory of Bologna, directed by Prof. A. Casali and Francesco Marconi; and, finally, a contribution by Melsens On the use of solutions of sulphurous acid, of neutral acid and sulphites, and of hyposulphites.

SOCIETIES AND ACADEMIES

London

Royal Society, June 11.—Researches in Spectrum Analysis in connection with the spectrum of the sun.—No. IV., by J. Norman Lockyer, F.R.S.

Maps of the spectra of calcium, barium, and strontium have been constructed from photographs taken by the method described in a former communication (the third of this series). The maps comprise the portion of the spectrum extending from wave-length 3900 to wave-length 4509, and are laid before the Society as a specimen of the results obtainable by the photographic method, in the hope of securing the co-operation of other observers. The method of mapping is described in detail, and tables of wave-lengths accompany the maps. The wave-lengths assigned to the new lines must be considered only as approximations to the truth. Many of the coincidences between lines in distinct spectra recorded by former observers have been shown by the photographic method to be caused by the presence of one substance as an impurity in the other; but a certain number of coincidences still remain undetermined. The question of the reversal of the new lines in the solar spectrum is reserved till better photographs can be obtained.

Royal Horticultural Society, July 1.—Scientific Committee. Dr. Hooker, P.R.S., in the chair.—Dr. Gilbert described the results of some investigations made by Mr. Lawes and himself on the conditions of the development of fairy rings. The mycelium of the fungus which produced the rings accumulated nitrogen in the superficial layers of the soil with the result of stimulating the growth of the grass and giving it the dark green colour which is characteristic of vegetation richly supplied with nitrogenous nutriment. When this luxuriant growth was grazed off, the soil was left relatively poor in nitrogen, and it was accordingly found that the superficial soil inside the rings was poorer in nitrogen than that outside it.—Dr. Hooker stated that seeds of the Kerguelen's Island cabbage (*Pringlea antiscorbutica*) sent to Edinburgh in a sealed bottle had germinated, while those sent to Kew in boxes had altogether failed. The following communication from Mr. Darwin was read:—"The leaves of *Pinguicula vulgaris* possess a power of digesting animal matter similar to that shown by the sundews (*Drosera*). Albumen, fibrin, meat or cartilage induce a secretion from the glands of the upper surface of the leaf, and their secretion becomes feebly acid (but not so much so as that of *Drosera*). Their secretion is reabsorbed, and causes an aggregation of the protoplasm in the cells of the glands, such as had been observed in other similar cases. Before excitement the glands were seen to be filled with a homogeneous pale greenish fluid; after the aggregation of the protoplasm it can be seen to move. When a row of insects or of cabbage seeds are placed near the margin of a leaf (or when a single insect is placed at one point), the whole margin (or one point) becomes curled considerably over in two or three hours; the apex of the leaf will not turn over towards the base. Small fragments of glass also cause a similar movement, but to a much less degree. The inflexed margin pours forth a secretion which envelops the flies or seeds, but pieces of glass cause no, or hardly any, increase of secretion. But here comes a puzzle: if the flies or fly be removed, the margin of the leaf turns back in less than twenty-four hours; but it does so also when a row of flies and cabbage seeds are left adhering; so that the use or meaning of the inflexion is at present quite a puzzle."—Mr. W. G. Smith showed engraved wood blocks of lignum vitæ, which he found more brittle than box.

Vienna

Imperial Academy of Sciences, Feb. 26.—Dr. Urba communicated a paper on some rocks of South Greenland, collected by Prof. Laube, from the second German Polar Expedition.—M. Pelz presented a memoir on determination of the axes of conical surfaces of the second order.—Dr. Adolph Meyer gave an account of new and little-known birds of New Guinea.—Dr. Exner read a paper on the employment of the ice-calorimeter for determining the intensity of the solar radiation; describing an apparatus by which the intensity may be measured directly in calorics, without (as in the Pouillet pyrheliometer) a change of temperature in the instrument, rendering correction necessary.—Dr. Brauer communicated a note on the development and mode of life of *Lepidurus productus* Bosc.—MM. Schulhof and Holetschek communicated the elements and ephemerides of a comet discovered on Feb. 20 by Prof. Winnecke at Strassburg.

Paris

Academy of Sciences, July 20.—M. Bertrand in the chair.—The following papers were read:—Note on the action of two current elements, by M. Bertrand. The assertion that two elements of the same direction attract one another is shown to be inexact, even for parallel elements, and does not agree even with Ampère's law. The author has solved the following problem:—A current element being given, to find in a point of space M the direction that must be assigned to another element, that their mutual action may be attractive, repulsive, or *nil*.—Extract from the Report of the Commission of the Agricultural Society of Chalon-sur-Saône, in the department of Saône-et-Loire, on Phylloxera, by M. Boully.—Reply to a criticism by M. Garrigou, contained in a recent note entitled "Carboniferous Limestone of the Pyrenees; Marbles of Saint-Béat and of Mont," by M. A. Leymerie.—On the efficacy of the method of submersion as a means of improving the vine in the Crimea: extract from a letter from M. Boutin to M. Dumas.—Employment of the *résidues d'enfer* of the oil-mills against *Phylloxera*, by M. Rousseau.—Third note on the electric conductivity of ligneous bodies, by M. Th. du Moncel.—On the stratification of the electric light, by M. Neyreneuf.—On the passivity of iron, by M. A. Renard. The author described several experiments illustrative of methods by which iron can be made passive in ordinary nitric acid.—Action of chloroform on sodic acetatic ether, by MM. A. Oppenheim and S. Pfaff.—The product of the reaction was saponified by soda and then acidulated with HCl. A new acid of the formula $C_9H_8O_5$ is thus obtained. This acid is dibasic and belongs to the aromatic series, the authors considering it an isomer of uvitic acid, the substituted groups occupying the positions 1 : 2 : 4.—On the isomeric compounds C_2H_4IBr, by M. C. Friedel. The author has repeated the experiments recently published on this subject by M. Lagermarck, and concludes therefrom that no third isomer of this formula exists.—On a development of heat produced by the contact of sodium sulphate with water at temperatures when the known hydrates of sodium sulphate cannot exist, and when the saturated solution of the salt deposits it only in the anhydrous state, by M. de Coppet.—Ethers of normal propylglycol, by M. E. Reboul.—Experiments on the generation of proto-organisms in media protected from aërial germs, by M. Onimus.—Indifference in the direction of the adventitious roots of a cactus, by M. D. Clos.—Observation of a bolide on the evening of July 18, at Versailles, by M. Martin de Brettes.—On the composition of potassium permanganate, by M. E. J. Maumené. The author concludes that the formula of the salt is Mn_2O_7KO.—New method of determining metals or oxides, by the same author.

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